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A sequential game of endowment effect and natural property rights

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HIGHLIGHTS

- It is a sequential game that links endowment effect with natural property rights.
- Natural property rights is jointly decided by endowment effect and relative contestability.
- Abundant idle resources helps to secure natural property rights.
- Third-party help is needed when the intruder significantly dominates in contestability.

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ABSTRACT

This study develops a sequential game between the incumbent and the intruder to examine how endowment effect decides natural property rights of a territory without third-party intervention.

1. Introduction

The existent literature has not reached a consensus exactly how social interactions secure property rights without third party intervention (North, 1990; Rauch, 2005).[1] One evidence-based answer is psychological entitlement due to animal territoriality (Brown, 1964) or endowment effect[2] out of human ownership (Levine, 2005). For instance, colonial history has had enduring impacts on the determinants of property rights (Acemoglu and Robinson, 2001). Maynard-Smith and Price (1973) and Maynard Smith (1982) adopts the Hawk–Dove model with bourgeois strategy between an incumbent and an intruder to explain animal territoriality, and this approach sheds lights on the endowment view of property rights in the mankind history (Gintis, 2007; Descioli and Karpoff, 2014). Although it nicely proves the property rights equilibrium where "if owner, play Hawk; if intruder, play Dove (Maynard Smith, 1982, p. 22)" and a counter argument that "if the property is sufficiently valuable, a property equilibrium will not exist (Gintis, 2007, p. 224)", this approach is subject to some limitations: (a) the anomaly with the Hawk–Dove game (Gintis, 2007) that overlooks the psychological mechanisms underlying the endowment effects; (b) dependence on an assumption that idle territories are rather abundant (Krier, 2005); (c) equal contestability of players; (d) fundamentally, a simultaneous move coordination game despite the sequential nature of a stereotype incumbent–intruder relationship.

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1 This study explores natural property rights in the shadow of third party intervention. We refer the third party literature to Gershenson (2002), Amegashie and Kutsoati (2007), Chang et al. (2007), Chang and Sanders (2009), Sanders and Walia (2014), and Chang et al. (2015).

2 By definition, endowment effect is "the fact that people often demand much more to give up an object than they would be willing to pay of acquire it (Kahneman et al., 1991, p. 194)".

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This paper proposes a sequential game of endowment effect and natural property rights. It attempts to overcome the aforementioned limitations with alternative settings in the theory. It suggests that security of natural property rights is determined by the perceived endowment effect of the incumbent, the inborn contestability of the intruder, and the exogenous availability of idle resources.

2. Model

2.1. Setting

It is a three-stage dynamic game with complete information between the occupier (denoted as O) and the ranger (denoted as R) who is the potential intruder. Assuming the territory has a survival value V, where $V > 0$, for R, and a subjective value of αV, where $\alpha \geq 1$ due to endowment effect, for O. In a sequence,

Stage I. O signals her commitment of defensive cost $c_o \geq 0$ to protect her territory. When $c_o = 0$, she gives up her ownership without fighting.

Stage II. After observing the signal from O, R decides if he intrudes. His invasion incurs an assaultive cost $c_r > 0$. Natural property rights is secured when he does not intrude, i.e., $c_r = 0$, given that $c_o \geq 0$. Alternatively, he exits peacefully and the game ends.

Stage III. If O and R fight, the Nature decides the winner with a Tullock contest (Tullock, 1980):

$$p_o = \frac{c_o}{c_o + kc_r}; \qquad p_r = \frac{kc_r}{c_o + kc_r}. \tag{1}$$

Here p_o and p_r are success probabilities of O and R, respectively. The winner possesses the territory, the loser exits, and the game ends.

In particular, we add a coefficient $k \in (0, \infty)$ to the conventional setting of Tullock contest, where k indicates relative contestability of R. When $k > 1$ (or $0 < K < 1$), it means R is more (or less) capable than O. $K = 1$ denotes an equal contestability which is a conventional assumption in of the Hawk–Dove game (Maynard Smith, 1982; Gintis, 2007).

If s/he peacefully exits, s/he has two choices: (a) seeking for a new territory, or (b) doing nothing. Seeking a new territory incurs a cost (of effort) $s \in (o, v)$, and the probability q that s/he finds an unoccupied territory depends on an exogenous factor $x \in [0, 1]$. x is the measurement of resource scarcity, where the greater x means the more idle resources. Without losing generality we assume $q = x$.[3] The expected payoff of findings a new territory is thus $\Delta = xV - s$. Obviously, $\Delta \in [-s, V - S]$, and it is monotonically increasing in x. Thus, there must exists a single $x^* \in (0, 1)$ that decides $\Delta^* = \Delta(x^*) = 0$. What is more, s/he collects zero payoff if s/he does nothing.

Lemma. *Each agent will choose seeking for a new territory rather than doing nothing, if and only if* $x \geq x^*$.

This lemma is straightforward. When $x \geq x^*$, the expected payoff of seeking behavior is no less than idle behavior. In opposite, when $x < x^*$, the expected payoff of seeking behavior is less than idle behavior.

[3] We may also argue that the probability of finding an unoccupied territory is dependent on the scarcity of resources as well as the search cost. That is to say, $q = q(x, s)$, where $q_x > 0$ and $q_s > 0$. The more idle resources (or the higher the search cost), the higher the probability to find an unoccupied territory. In addition, $q(0, s) = 0$, and $q(1, s) = 1$, i.e., any level of s does not secure an unoccupied territory when all is occupied, and any level of s secures an unoccupied territory when all is idle. This setting still claims the existence of an x^* that satisfies $\Delta^* = 0$. Therefore, our conclusions remain unchanged.

2.2. Solution

First we consider the situation $x \geq x^*$, then we investigate the simpler situation $x < x^*$, and finally we draw propositions. We adopt the standard backward-induction analysis.

Given $x \geq x^*$, $\Delta \geq 0$. In the stage III, the contest occurs with both c_o and $C_r > 0$, after which the winner of the contest stays and the loser leaves away. Payoff of each agent can be written as follows:

$$\pi_o = p_o \alpha V + (1 - p_o)\,\Delta - c_o \tag{2}$$

$$\pi_r = p_r V + (1 - p_r)\,\Delta - c_r. \tag{3}$$

In the stage II, R chooses c_r to maximize π_r with the optimal level of c_r^*[4]

$$c_r^* = \frac{\sqrt{kc_o(V - \Delta)} - c_o}{k}. \tag{4}$$

In addition, π_r should be larger than Δ, otherwise he would peacefully exit without contest. In a similar logic, $\pi_o \geq \Delta$. We will reexamine this inequality condition later.

In the Stage I, O chooses c_o to maximize π_o given c_r^* at

$$c_o^* = \frac{(\alpha V - \Delta)^2}{4k(V - \Delta)}. \tag{5}$$

Substituting c_o^* into Eq. (4), we have

$$c_r^* = \frac{(\alpha V - \Delta)\,[2k\,(V - \Delta) - (\alpha V - \Delta)]}{4k^2(V - \Delta)}. \tag{6}$$

A contest demands $c_o^* \geq 0$ and $c_r^* \geq 0$. Since $\alpha \geq 1$ and $\Delta < V$, $c_o^* \geq 0$ is clearly satisfied. However, $c_r^* \geq 0$ requires $[2k\,(V - \Delta) - (\alpha V - \Delta)] \geq 0$, i.e. $\alpha \geq \underline{\alpha}$ where

$$\underline{\alpha} = \frac{2k\,(V - \Delta) + \Delta}{V}. \tag{7}$$

It is easy to prove that when $c_o^* \geq 0$ and $c_r^* \geq 0$, $\pi_r \geq \Delta$ and $\pi_o \geq \Delta$ (see Appendix A). That is to say, individual rationality of contest is satisfied.

Now examine another situation $x < x^*$ i.e. $\Delta < 0$. The loser of contest would rather avoid contest and walk away,[5] which leads to $\Delta = 0$. Hence, we simply derive the game equilibrium at $\Delta = 0$.

Considering $\alpha \geq 1$ and Eq. (7), contest occurs when $\alpha < \max\{\underline{\alpha}, 1\}$, while no contest (i.e. $c_r^* = 0$) happens when $\alpha \geq \max\{\underline{\alpha}, 1\}$. Simple calculation shows that $\max\{\underline{\alpha}, 1\}$ equals to $\underline{\alpha}$ if $k > 1/2$ or 1 if $k \leq 1/2$.

Proposition 1. *In a territory contest game, natural property rights of the initial occupier is respected without third-party enforcement if* $\alpha \geq \max\{\underline{\alpha}, 1\}$, *where* $\underline{\alpha} = [2k\,(V - \Delta) + \Delta]\,/V$.

Shown on Fig. 1, the area above the thick solid curve $\max\{\underline{\alpha}, 1\}$ is the natural property area, in which no fight would break out because $c_r^* = 0$. Given resource availability (x), natural property rights is decided by endowment effect of O and relative contestability of R: the higher the contestability (k) of R, the higher the endowment effect (α) of O is needed to go above the $\max\{\underline{\alpha}, 1\}$ curve (i.e. secured natural property rights), and vice versa. When $k \leq 1/2$, R always peacefully leaves even if O does not hold endowment effect. Once $k > \frac{1}{2}$, O must possess endowment effect ($\alpha > 1$) to hold off R. Furthermore, when idle resources (x) are more ample, Δ increases and the sloping section of the $\max\{\underline{\alpha}, 1\}$ curve is flatter. In other words, the area of natural property rights expands.

[4] The negative root is ignored.

[5] Whether s/he seeks a new territory or does nothing is dependent on the resource availability x.